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Does the Environment Kuznets Curve exist in Singapore?

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Abstract

The Environment Kuznets Curve (EKC) shows that there exists an inverted 'U' relationship between indicators of environmental degradation and economic growth. This means that environmental degradation first increases (worsens), and then decreases as per capita income increases. The hypothesis is tested for the case of Singapore. The paper finds that Granger causality flows from export performance, trade intensity and energy consumption to CO_2 emission, and the EKC exists in the long run, but not in the short run.

Keywords:

environment, Singapore

Introduction

There was a sense of extreme vulnerability following Singapore's split from the Malaysian Federation in 1965 as it seemed unlikely that Singapore would be able to survive as a city along with no hinterland and no natural resources. Singapore not only survived as a nation state. Under the leadership of the pioneer generation of the People's Action Party (PAP), Singapore solved many problems such as communism and high unemployment rate, and experienced rapid economic growth. Singapore has transformed from a trading port of primary products to an international transportation and logistics hub, a financial *entrepo*t, a centre for international tourism, education and medical centres, and from a third world country to a first world country.

As the industrial base grew to include chemical and electronic industries, Singapore understood that it had to take into consideration the adverse effect of industrialization on the quality of environment. In April 1970, the Anti-Pollution Unit (APU) was formed. Established under the Prime Minister office, the APU has regulatory power to reject industries deemed to be too polluted from operating in Singapore (Tan, 2008). The Clean Air Act was passed in 1971 to prevent and controlling air pollution. The stringency in effluent and emission regulations was deemed necessary as local companies tend to view environmental protection as a deterrent to profit generation (Perry and Singh, 2002). The Ministry of Environment was later instituted in 1972, and took over the task of cleaning up the Singapore River and Kallang Basin Catchment.[1]

[1] In 2004, the Ministry of Environment was renamed as the Ministry of the Environment and Water Resources (MEWR) to reflect its expanded role to include water management.

The economic development model of Singapore has been well documented [see, for example, Huff (1994) and Low (2001)]. This paper aims to find out whether the Environment Kuznets Curve (EKC) exists in Singapore. The EKC hypothesizes the existence of an inverted 'U' relationship between indicators of environmental degradation and economic growth. This means that environmental degradation first increases (worsens), and then decreases as per capita income increases. Several empirical results suggest that EKC exists (World Bank, 1992; Shafik and Bandhyopadhyay, 1992; Seldon and Song, 1994; Grossman and Krueger, 1995; Stern, Common and Barbier, 1996; Cole, 2003; Frankel and Rose, 2005; Ahmed and Qazi,, 2014; Shahbaz et al, 2014). Our results show that Granger causality flows from export performance, trade intensity and energy consumption to CO_2 emission, and the EKC exists in the long run, but not in the short run in Singapore.

The Case of Singapore

Singapore is a small island developing state, sharing many of the characteristics of the pacific islands including dense population and small physical space. Although the city state is largely protected from hurricane and other natural disasters, rising sea level is a matter of concern.[2] As Ng and Mendelsohn (2005) have showed, sea level inundation could lead to loss of dry land of up to 17 sq km (2.7% of the Singapore's total land area). Singapore has constructed sea walls and put in place a good drainage system to keep the sea out.

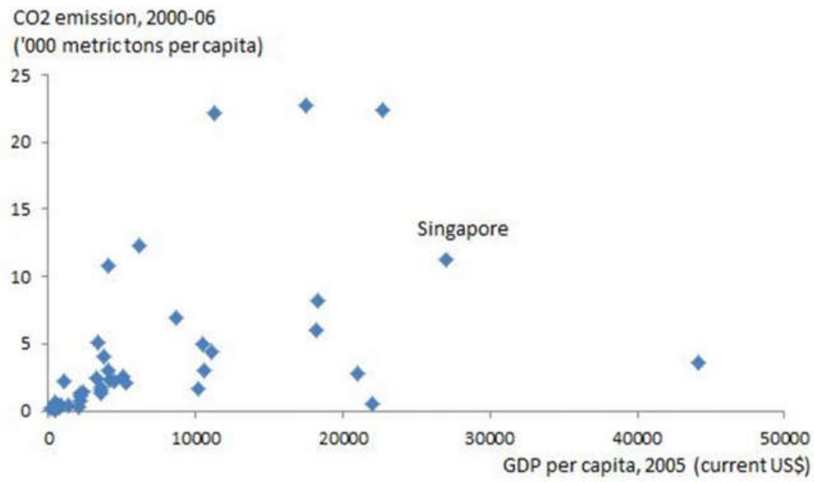
Without any significant agricultural land or landfill sites, Singapore does not emit significant amount of methane gasses. Carbon dioxide (CO_2) is the primary greenhouse gas emitted in the city state, resulting from the use of fossil fuels in power generation and the industrial, transport and commercial and residential sectors. As shown in Figure 1, CO_2 emission in the city state has been on a rising trend averaging 11.46 metric tons per capita in the 1980s before stabilizing at an average of 14.26 metric tons in the period 1990-2005.

Figure 1: Annual CO_2 emission (1981-2005)

[2] Much of Singapore's land is less than 15 metres above sea level (ENV, 2000: 31).

Source: World Economic Outlook Database, October 2008, International Monetary Fund (IMF)

Figure 2: CO_2 **emission versus GDP per capita (selected countries)**



Source: United Nations (2007) World Statistics Pocketbook: Small Island Developing States, United Nations (New York)

Figure 2 considers the small island countries as classified by the United Nations (n = 42). Comparatively, Singapore was ranked as the fifth highest emitter of CO_2, and second in terms of GDP per capita, after British Virgin Islands. Accounting for only 0.2% of global CO_2 emission, Singapore adopts a pragmatic approach and will do its "fair share as part of a collective global effort" (Phua, 2008). Singapore's position is that it could not volunteer to reduce its emissions at the cost of economic growth if other countries fail to do their part. In the run up to the summit at Copenhagen in 2009, Singapore committed to cut greenhouse gas emissions by 16% by 2020 but she made it clear that this would take effect only if all countries cut emissions and if other countries offer significant pledges. Singapore's commitment pales in comparison with the 40-50% cut committed by China but aligns closely with the United States declaration to reduce U.S. greenhouse gas emissions by 17% of 2005 levels by 2050 under the Waxman-Markey American Clean Energy and Security Act of 2009.[3]

To this end, Singapore has acceded to the Kyoto Protocol. The decision has been described as a significant shift in Singapore's policy towards CO_2 emission, from denying its obligation to set emission target as it clings on to its developing country status to the announcement of putting in place a plan to reduce carbon intensity. It has been argued that Singapore's decision to accede to the Kyoto Protocol was purely nationalistically orientated "to protect the country's international image and to benefit from the economic opportunities that the protocol opens up" (Hamilton-Hart, 2006: 375).

[3] As Singapore puts it, this was largely due to the higher base level. 'Singapore to pledge 16% cut in gas emissions', *The Straits Times*, 3 December 2009.

Empirical Results

This paper considers the relationship between the level of CO_2 emission, economic performance, trade openness and energy consumption for Singapore. The annual data used in this study are obtained from World Bank's World Development Indicators, for the period from 1971 to 2011. The use of CO_2 rests on the fact that the gas accounts for over half of the effect of global warming.[4]

Equation (1) establishes the dynamic relationship between CO_2 emission, economic performance, trade openness and energy consumption.

$$C_t = f(Y_t, Y_t^2, X_t, E_t) \qquad (1)$$

In the equation, C is CO_2 emission per capita, Y is GDP per capita, Y^2 is GDP square per capita, X measures the total trade volume per capita and E represents energy use (kg of oil equivalent) per capita.

Equation (1) can be converted to the log linear equation as shown below:

$$\text{In } C_t = \beta_0 + \beta_1 \text{ In } Y_t + \beta_2 (\ln Y_t)^2 + \beta_3 X_t + \beta_4 E_t + U_t$$

where U is the error term. The EKC postulates that $\beta_2 < 0$.

The time series properties of the variables are examined using two unit roots test – the augmented Dickey-Fuller test and Phillips-Perron test – for the null hypothesis of non-stationary. Table 1 shows the results for the test on non-stationary, suggesting that the series are integrated of order one, I(1). This implies the possibility of cointegrating relationships.

Table 1: Unit roots tests results

	Augmented Dickey Fuller Test		Phillips-Perron Test	
Variables	Level	First difference	Level	First difference
ln C	0.0343	-8.4307*	-1.7190	-8.7364*
ln Y	-2.4985	-4.7173*	-2.4500	-4.5650*
ln Y^2	-2.4199	-4.5253*	-2.4199	-4.4173*
ln X	-3.6920	-5.7073*	-2.6599	-5.7236*
ln E	-1.7125	-7.2858*	-1.6385	-7.2949*

Figures in the table show the t-statistics. The regressions are measured with trend and intercept term. * indicates rejection of null hypothesis of non-stationary at 1% significance level.

To test for cointegration, this paper uses the well-known methodology developed by Johansen (1991) who modeled the time series as a reduced rank regression. Equation 2 is estimated, and the residuals are used to compute two likelihood ratio test statistics: the trace and maximal eigenvalue tests.

$$\Delta Z_t = \mu + \sum_{i=1}^{p-1} \Gamma_i \Delta Z_{t-i} + \prod Z_{t-1} + \varepsilon_t \qquad (2)$$

[4] Jeffrey Sachs (2008: 37) has labeled CO_2 as the "most important greenhouse gas" affecting the Earth's climate system.

Where Z_t is an (nx1) column vector of p variables, μ is an (nx1) vector of constant terms, Γ and Π represent coefficient matrices, k is the lag length, and $\varepsilon \sim N(0,\Sigma)$.

Table 2 provides the results for the Johensen cointegration test. The results suggest that there is at least one cointegrating equation among the variables.

Table 2: Johansen Cointegration Test

Number of cointegration equations	Trace Statistics	Maximum Eigenvalue Statistics
None*	96.84439	39.21114
At most 1	57.63324	23.75009
At most 2	33.88316	16.45690
At most 3	17.42626	10.25048
At most 4	7.175772	7.175772

* denotes rejection of the hypothesis of zero number of cointegration equation at 5% significance level

The existence of cointegration implies that an Error Correction Model (ECM) specification is appropriate. Table 3 shows the results of Granger causality based on ECM, and it indicates the existence of a long-run relationship between CO_2 emission and economic performance, trade intensity and energy consumption. More specifically, the coefficient of Y^2 is negative and significant, implying that the EKC exists in the case of Singapore. The Singapore's case shows that as economic performance increases, the quality of the environment as measured by CO_2 emission first increases, and then falls.

Table 3: Vector Error Correction Model Estimates

Variables	Coefficient	t-statistics
Long-run estimates		
Y	4.9288	2.1797*
Y^2	-2.8429	-2.6251*
X	-0.8819	-2.9646*
E	-0.5717	-3.2002*
Constant	57.6001	
Short run estimates (lagged-difference)		
ECM	-0.3303	-1.7260**
C	-0.0892	-0.4118
Y	1.9389	0.3227
Y^2	-0.9641	-0.3231
X	0.1612	0.3851
E	0.2030	0.7862
Constant	-0.0248	-0.2573
Diagnostic test	P-value	
Heteroscedasticity	0.5412	
LM Serial Correlation	0.5728	

*, ** significant at 5% and 10%, respectively

The coefficient for X is negative and significant, suggesting that trade reduces pollution level through innovation and empowerment of the consumers to demand cleaner production of goods and services. Trade promotes a reduction in pollution through economic growth, 'accelerated innovation, an international ratcheting up of standards, empowerment of the consumers, or some other channels' (Frankel, 2005: 11). This may represent one part of the inverted 'U' Environment Kuznets Curve (EKC) which stipulates the worsening of environmental degradation in the early stage of developed followed by improvement in the later stage.

The coefficient for E is negative and significant. It implies that the increase in energy consumption has not led to more emission of CO_2. One possible explanation is that Singapore has relied extensively on piped natural gas and liquefied natural gas in meeting its energy needs. Natural gas generates 95% of the electricity in Singapore, up from 26% in 2001, and the growth is largely driven by technology advancements in transportation, availability of the resource from Malaysia and Indonesia and lower cost of production. The results suggest that the declined in carbon intensity energy production has reduced CO_2 emission from power generation.

It is also worth noting that the lagged ECM term is statistically significant, implying that past equilibrium errors affect current outcomes. However, there is no evidence of short run causality running from Y, X and E to CO_2 emission.

Concluding Remarks

This paper considers the relationship between economic performance and environmental quality, and in particular the Environment Kuznets Curve (EKC) hypothesizes, which states the existence of an inverted 'U' relationship between indicators of environmental degradation and economic growth. It contributes to the literature by testing the EKC hypotheses in Singapore by using cointegrated vector autocorrelation method.

Many people are hopeful that urbanization, industrialization and other processes of economic development will bring a better tomorrow. This paper lends support to that hope. Using the case of Singapore, this paper finds that while initial economic progress has led to worsening of the environmental problem, continued strong economic performance in the long run has the effect of reducing CO_2 emission. In this regard, pressure on the environment exerted by growth induced factors is justified so long as the environmental degradation does not exceed the threshold irreversible level. The perception that economic growth is not necessary harmful to the environment lends support to the proposition to push ahead their growth agenda and search for sources of economic growth.

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